JOINTED MIRROR ARM

The invention relates to an jointed mirror arm in accordance with the preamble to the main claim, specifically an intermediate jointed arm with at least two tubular parts that are joined to one another via a joint having a tilted mirror and that are to be arranged at different solid angles to one another because of this joint and that form a beam path for the radiation, with a stationary inlet at a first tubular part for introducing radiation from a stationary optical source, and with any desired outlet site of the intermediate jointed arm that is different from the inlet site and that is on a last tubular part for the radiation outlet.

Such jointed mirror arms are known per se and are for transferring radiation, e.g. that of a laser, from a stationary source to a site of use that can vary in location, e.g., a handpiece on the end and downstream of the outlet of the jointed mirror arm on the last tubular piece, such as is the case e.g. during the use of lasers in dermatology, in dental technology, or during surgery. At the inlet a static radiation is coupled in in the sense that the laser is arranged rigid with respect to the jointed mirror arm and its radiation is coupled into the latter; the deflection and change to the position of the exiting beam can be effected using moving and locationally displacing the outlet of the jointed mirror arm and/or of the endpiece e.g. the handpiece located there. Instead of this, it is also possible to deflect the

beam by means of a scanner in the handpiece downstream of the jointed mirror arm.

It is disadvantageous in this that the beam deflection must be miniaturized in a complicated manner by means of the scanner and is also subjected to dynamic disturbances by the movement of the outlet of the jointed mirror arm and/or the handpiece.

The object of the invention is to embody in a simpler manner and a manner less sensitive to interference a generic jointed mirror arm with beam deflection.

This object is inventively attained with a generic jointed mirror arm in accordance with the preamble to the main claim using its characterizing features in that a scanner for the radiation is arranged upstream of the inlet of the intermediate jointed arm and in that an optical imaging system forming the scanner is provided at a site downstream of the outlet of the intermediate jointed arm in the at least two tubular parts of the intermediate jointed arm.

In other words, in accordance with the invention the scanner is moved from the outlet or the handpiece into the static part upstream of the inlet of the jointed mirror arm and a physically extended image or aperture diaphragm e.g. of the scanner is optically imaged from the inlet through the beam path of the jointed mirror arm to its outlet.

In this manner the cross-section required by the scanned beam advantageously remains small, even at large transfer lengths. The scanner with respect to its size is also not subject to any limitations because it can be arranged with standard components upstream of the inlet of the jointed mirror arm without any structural limitations.

In one preferred further development of the invention, the imaging system can comprise one or a plurality of imaging stages, whereby each imaging stage is provided with at least two lenses having an intermediate focus therebetween.

Advantageously the joints with the tilted mirrors can be placed at any location in the beam path. It is useful that locations are preferred at which the tilted mirror is not at the site of an intermediate focal point in order to avoid focused spots on the tilted mirrors.

By rotating the joints of the jointed mirror arm the transferred image rotates. This means the coordinate allocation between inlet and outlet are lost. This is important in special applications (e.g. targeted approach of coordinates using XY scanners). The rotation of the transferred image can be measured and compensated using special image rotation optics, e.g. using marks. The following can be used as marks:

- a self-illuminating or illuminated structure
- a structure as above in the image field (point, line, etc.)

- a structure as above on the edge of the imaged field
- a structure as above on a radiation limiting surface (e.g. screen)
- a specific scanning position or scanning pattern

The measurement can be performed using the following listed measures:

- imaging of a mark using the jointed mirror arm
- measurement and evaluation of image orientation (image position of imaged structure)
- measurement of image position by means of position-sensitive detector
- measurement by means of individual detector e.g. for signal maximum
- measurement using control and regulation of an image rotation stage via aforesaid sensor signals.

In addition, the following additions can be made to the inventive jointed mirror arm.

- Use of measurement beam path and sensors for whole-system monitoring
- Control of the adjustment status of the jointed mirror arm.
- Safety switch for e.g. laser. I.e., Light e.g. of the arm disappears, also the monitor signal and then the light source (e.g. laser) can be turned off.

Additional useful embodiments and further developments of the invention are explained in greater detail in the following with reference to the drawings.

Figure 1 is a schematic beam path in an jointed mirror arm.

Figure 2 is a schematic section of an jointed mirror arm with the beam path

Figure 1 is a schematic illustration of an optical beam path, in this case a telecentric arrangement. A is the inlet-side radiation that strikes a real scanner. Downstream of this is an imaging stage of an imaging system A' with two lenses 511, 512 that form an intermediate focal point 513 therebetween. A scanner image 10' results downstream of this imaging stage A'. Downstream of this is an additional stage A" that also has two lenses 531 and 532 with an intermediate focal point 533 arranged therebetween. The scanner image 10" is arranged downstream thereof.

This schematic beam path in accordance with Figure 1 will now be explained using a cross-section of an jointed mirror arm labeled 5 in Figure 2. In it, A indicates the incoming radiation that strikes the stationary scanner and thus the beginning of the jointed mirror arm 5. Connected to the scanner 10 is the first tubular part 11 of the jointed mirror arm 5, in which the first imaging stage A' is arranged with the two lenses 511 and 512 that form an intermediate focal point 513.

Connected to the fixed tubular part 51 is a tubular part 52 that can be rotated via a bearing 60 and that has a mirror 56 that is arranged at a 45° angle with respect to the optical axis of the first tubular part 51. The connecting tubular support on the side of the tubular part 52 facing away from the first tubular part 51

runs to the mirror 56 at a 45° angle and perpendicular to the axis, that is, to the optical axis of the first imaging system's A' perpendicularly-running tubular axis and is itself provided at its free end with a bearing 61 on the tubular piece 524.

The tubular part 53 is likewise provided with a tubular section 534 that is arranged perpendicular to the extension of its axis and with which it can be rotated about the bearing 61. Provided between this tubular section 534 and the tubular part 53 running perpendicular thereto is an additional mirror 57 that is arranged at a 45° angle with respect to the two tubular axes.

This tubular part 53 has an additional imaging stage providing an optical image A" and with lenses 531 and 532 that form an intermediate focal point 533 therebetween and is provided at its rear end with another bearing 62.

Provided around this bearing is an additional tubular part 54 with a mirror 58 and a tubular section 544 that extends perpendicular to the axis of the tube 53 and located at the end of which is a last bearing 63.

Attached rotatable about this bearing is a tubular section 554 of the tubular part 55, the axis of which runs perpendicular to that of the tubular section 544 of the tubular part 54 and provided with a mirror 59 at a 45 ° angle to the two aforesaid axes.